HETA 2000-0262-2833
Southern Supply & Manufacturing Company, Inc.
St. Petersburg, Florida

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PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Josh Harney and Doug Trout of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Ardith Grote. Desktop publishing was performed by David Butler. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of metalworking fluid exposures in the wet grinding department

The owner of Southern Supply & Manufacturing Co., Inc. wanted to know if airborne metalworking fluid (MWF) mist in the wet-grinding area might cause breathing problems for the machine operators.

What NIOSH Did

- **We sampled the air for MWF.**
- **We talked to employees about their work and their health.**
- **We looked at the mist collectors to see if they worked well.**

What NIOSH Found

- **Workers in the wet grinding area are exposed to MWF above the NIOSH limit.**
- **The mist collector inlets are too far from the grinding wheels.**
- **New machinery may have increased the amount of noise.**
- **No current workers reported having any breathing problems related to work.**
- **Some workers may be having skin problems related to work.**

What Southern Supply & Manufacturing Co., Inc. Managers Can Do

- **Put the mist collector inlets closer than 10 inches to the work surface.**
- **Enclose the wet grinders.**
- **Provide respirators and a respiratory protection program to employees until MWF exposures are reduced.**
- **Improve education and training concerning MWF use.**
- **Conduct a noise survey of the whole building.**

What the Southern Supply & Manufacturing Co., Inc. Employees Can Do

- **Use gloves, sleeve protectors, aprons, coveralls, etc., to keep MWF off your skin.**
- **Wash MWF off your skin.**
- **Report any health problems to your boss if you think they're work related.**

What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report # 2000-0262-2833

Health Hazard Evaluation Report 2000-0262-2833
Southern Supply & Manufacturing Company, Inc.
St. Petersburg, Florida
March 2001

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SUMMARY

In April 2000, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a Health Hazard Evaluation (HHE) at the Southern Supply & Manufacturing Company, Inc. in St. Petersburg, Florida. Southern Supply & Manufacturing Co., Inc. manufactures shears, scissors, and thread nippers for the garment, textile, and other sewn products industries. The owner of Southern Supply & Manufacturing Co., Inc. was concerned about worker exposures to synthetic metalworking fluids (MWF) in the wet-grinding area of the facility. NIOSH investigators conducted a site visit on September 21-22, 2000. It included opening and closing conferences, worker interviews, and environmental monitoring.

Personal breathing zone air samples of MWF were collected from all six grinders working during first shift. On an 8-hour time-weighted average basis, the exposures to the thoracic fraction of MWF aerosol ranged from 0.78 - 3.95 milligrams per cubic meter of air (mg/m^3). The NIOSH Recommended Exposure Limit is 0.4 mg/m^3, thoracic fraction. Each pair of grinders shares one mist collector, which is rated to draw 1200 cubic feet of air per minute. The inlets for these units were 12-18 inches behind the grinding surface.

Wet-grinders' exposures to MWF were between 2 and 10 times the NIOSH Recommended Exposure Limit of 0.4 mg/m^3, thoracic fraction. The local exhaust ventilation inlets are placed too far from the grinders to be effective. Recommendations are offered to reduce MWF exposures through improved enclosure and local exhaust ventilation.

Keywords: SIC Industry Group 3541 (Metalworking Machinery and Equipment, Grinding Machines), grinding, metalworking fluid, MWF, thoracic particulate, total particulate, mist collector, asthma, machine shop, synthetic MWF

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INTRODUCTION

In April 2000, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a Health Hazard Evaluation (HHE) at the Southern Supply & Manufacturing Company, Inc. in St. Petersburg, Florida. Southern Supply & Manufacturing Co., Inc. manufactures shears, scissors, and thread nippers for the garment, textile, and other sewn-products industries. The owner was concerned about worker exposures to synthetic metalworking fluids (MWF) in the grinding area of the facility. Specifically, the HHE was requested based, in part, on concern related to a former grinding area employee who had reported that exposure to the MWF caused aggravation of asthma. Workers at this facility are not represented by a union. A NIOSH site visit to Southern Supply & Manufacturing Co., Inc. on September 21-22, 2000, included opening and closing conferences, interviews with workers, air sampling for MWF, and an assessment of the local exhaust ventilation (LEV) in the wet-grinding area.

BACKGROUND

Southern Supply & Manufacturing Co., Inc. operates one work shift daily, and employs 32 full-time employees (plus several temporary employees depending on product demand). Six machinists work in the wet-grinding area, which occupies roughly 500 square feet of the 10,000 square feet facility. The wet-grinding is done using a MWF (Grind Safe®) which is flooded onto the 4.5-inch carbon steel blades as they are ground. There are 6 wet-grinding machines. Each grinding wheel is stationary; the machine operators attach parts to a magnetic grinding table that slides into the machine where grinding occurs. Each grinder has its own 25-30 gallon MWF sump. The grinders also have a local exhaust plenum connected to a Royal Filtermist® (model F1200) mist collector. The grinders were not designed by their manufacturer to be fully enclosed, but splash guards have been added by Southern Supply & Manufacturing Co., Inc. so that the grinding surfaces are largely shrouded. Each grinder is drained of used MWF and filled with fresh MWF every two weeks. One-quart additions are made daily to maintain sump volume. Machine operators in this area wear aprons and rubber boots. Rubber gloves and ear plugs are made available to them, but their use is not required.

METHODS

Air Sampling

Personal breathing zone (PBZ) air samples for MWF were collected on a 37 millimeter (mm) closed-face cassette containing a tared 2 micrometer (µm) pore-size polytetrafluoroethylene (PTFE) filter attached to either the right or the left lapel area of the worker. A thoracic cyclone was attached to the sampling cassette so that only the thoracic fraction of the aerosol would be collected. The thoracic portion of an aerosol is the portion that will penetrate past the nasopharynx, i.e., those particles with an aerodynamic diameter of 10 µm or less.[1] Tygon® tubing connecting the sampler and a personal sampling pump allowed air to be drawn through the sampling train at a flow rate of 1.6 liters per minute (Lpm).[2] Co-located area samples were collected using thoracic samplers and traditional total particulate samplers. The total particulate samplers consisted of a 37 mm closed-face cassette with a 2 µm pore-size PTFE filter, Tygon tubing, and a personal sampling pump calibrated at 2 Lpm.[3] The analyses of both PBZ and area samples were conducted in the same manner. The cassettes containing the filters and back-up pads for each sample were placed into a

desiccator for at least 16 hours for equilibration before analysis.

The particulate mass for each sample was determined by measuring the gross weight of each filter on an electrobalance and subtracting the previously determined tare weight of the filter. The filters for each sample were then extracted using a 1:1:1 blend of dichloromethane, methanol, and toluene. After drying in a vacuum oven for three hours, the filters were reweighed on the electrobalance. The extractable mass was then calculated by subtracting the post-extraction filter weight from the pre-extraction filter weight. If the collected aerosol was largely extractable, then it was presumably MWF.

The limit of detection (LOD) and limit of quantification (LOQ) for particulate mass analysis were determined by using the standard deviation of the five field blanks. The LOD is three times the standard deviation of the field blanks, and the LOQ is ten times the standard deviation of the field blanks. The LOD for the particulate mass analysis is 0.006 milligrams (mg), which equates to a minimum detectable concentration (MDC) of 0.007 milligrams per cubic meter of air (mg/m^3) based on a sample volume of 857 liters (L). The LOQ was 0.02 mg/sample, yielding a minimum quantifiable concentration (MQC) 0.023 mg/m^3 based on a sample volume of 857 L. The LOD for the extractable fraction was 0.03 mg/sample, which equates to an MDC of 0.035 mg/m^3, assuming a sample volume of 857 L. The LOQ was 0.1 mg/sample, which equates to an MQC of 0.117 mg/m^3, assuming a sample volume of 857 L.

Local Exhaust Ventilation Assessment

The owner's manual for the Royal Filtermist model 1200 mist collectors was reviewed. A three-point traverse of each LEV inlet was made using a TSI VelociCal Plus® thermoanemometer (model 8360) to measure the inlet face velocity. Multiplying the average face velocity by the area of the opening yields an estimation of the volumetric flow rate through that inlet. Adding the results from all the inlets attached to a single mist collector yields the total volumetric flow rate for that mist collector. Based on these results, the performance of the mist collector can be determined and compared to the design specifications.

Employee Interviews

The NIOSH medical officer interviewed all six of the current employees working in the wet-grinding area. The employees were asked about workplace exposure to MWF and about health effects potentially related to those exposures. The former employee who was reported by management to have respiratory health effects possibly related to working in the machining environment could not be reached at the last known home telephone number.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some

hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, thus potentially increasing the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[4] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®)[1], and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[5] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 95–596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-to-10-hour workday. Some substances have recommended STELs or ceiling values which are intended to supplement the TWA values where there are recognized toxic effects from higher exposures over the short term.

Metalworking Fluids

NIOSH recommends that occupational exposures to MWF aerosols be limited to 0.4 mg/m^3 of thoracic particulate mass as a TWA concentration for up to 10 hours (hrs)/day during a 40-hr work week, measured according to NIOSH Method 0500.[3] The 0.4 mg/m^3 concentration thoracic particulate mass corresponds to approximately 0.5 mg/m^3 total particulate mass.[6]

This REL is intended to reduce the respiratory disorders associated with MWF exposures in the workplace. However, concentrations of MWF aerosols should be kept below the REL where possible because some workers have developed work-related asthma, hypersensitivity pneumonitis (HP), or other adverse respiratory effects when exposed to MWF at lower concentrations.[6] In addition, limiting dermal (skin) exposures is critical to preventing allergic and irritant skin disorders related to MWF exposure. In most metalworking operations, it is technologically feasible to limit MWF aerosol exposures to 0.4 mg/m^3, thoracic fraction, or less.

RESULTS

Air Samples

The indoor temperature was 74°F and the relative humidity was 51% during the air sampling conducted on September 22, 2000. Production rates were reported as normal that day. The results from air sampling are shown in Table 1. All six PBZ air samples were above the REL of 0.4 mg/m^3, with 8-hr TWAs ranging from 0.78 - 3.95 mg/m^3. The thoracic particulate area sample collected in the wet-grinding area had a

concentration of 1.11 mg/m^3 8-hr TWA, while the total particulate sample paired with it was voided because its pump failed. These seven samples taken from the grinding area were almost entirely extractable, with the mean percentage of extractable particulate as a component of the thoracic particulate being 89%. This indicates that the particulate sampled in the machining area was, as expected, largely MWF. The two area samples collected in the assembly area had airborne particulate concentrations of less than 0.3 mg/m^3; and the mean percentage of extractable particulate as a component of the thoracic particulate in these two samples was 54%, indicating that there was much less MWF present in the assembly areas compared to the wet-grinding area.

Ventilation

Each pair of grinding machines shared a single mist collector, rated by the manufacturer to draw 1200 cubic feet per minute (cfm). The inlet plena were approximately 10" x 4", and were placed between 12 - 18" from the grinding surface on each machine with the mouth of the inlet facing the floor. The plena were placed on the opposite side of the grinding action from the machine operator. The path from the grinding surface to each exhaust plenum was partially obstructed by the grinder at each work station. Each grinding wheel was nearly fully shrouded, but workers have covered the remaining openings with aprons, rags, etc. attempting to reduce the MWF mist escaping the machine. The exhaust plena are not directly attached to these enclosures. Assuming each mist collector was performing well and drawing 1200 cfm as designed, each of the two plena attached to it would draw about 600 cfm if the connecting ductwork characteristics were similar. Under these conditions, it is reasonable to assume a minimum capture velocity for MWF aerosol of 100 feet per minute (fpm).[7] Based on standard calculations, in order to achieve this minimum capture velocity the maximum unobstructed distance between the exhaust inlet and the grinding surface should be no more than 10".[7]

Measurements of the exhaust inlet face velocity showed that the mist collectors servicing the inside-polish grinders and the inside-slab grinders drew slightly more than 1200 cfm, while the mist collector servicing the outside-slab grinder drew closer to 1100 cfm. This indicates that these mist collectors are operating at 90% or better of their design capacity. The three-point traverse used to measure the exhaust inlet face velocity, however, is best used in this case as a qualitative measure of how well the mist collector is performing. More face velocity data points would be needed to accurately calculate the volumetric flow rate.

Metalworking Fluid Management Program

Each grinding machine has its own 25-30 gallon sump which recirculates the synthetic Grind Safe® MWF. One worker serves as the coolant technician, in addition to operating a grinding machine, and is in charge of making daily MWF 'adds' to maintain the volume of MWF in each machine each day. Once every two weeks, the coolant technician disposes the used MWF in each machine and replaces it with fresh MWF. Both the daily 'adds' and the biweekly 'adds' are made with MWF at approximately 10% concentration (diluted with water). Due to the frequent MWF change-out schedule, no fluid monitoring is done for microbial contamination. No biocides, pH adjusters, or other MWF additives are routinely used. We observed that employees in the wet-grinding area had ready access to clean gloves, clean towels and shop rags, and hand washing stations.

Employee Interviews

The six current employees in the machining area ranged in age from 40 to 59 years, and had been employed at the company from 1 month to 16 years. All reported routinely wearing aprons and gloves during their machining operations. Five of the six employees reported that there was easy access to clean shop rags and/or paper towels for cleaning purposes. All employees reported easy access to hand washing stations. None of the employees reported respiratory problems related to their work. All reported the presence of mist generated by the machines. Two of the six employees reported occasional irritation of the nose which was thought to be related to the MWF mist. Those two employees noted that the irritation resolved after leaving the workshop. One employee noted occasional itching of the skin, thought related to skin contact with the MWF or the MWF mist. That employee noted that the skin itching resolved after the skin was washed. One employee noted scratches on the arms related to the MWF; the scratches were reported to be itchy and sometimes accompanied by a skin rash. Inspection of the arms of that employee revealed multiple superficial linear scratches over both arms, extending from approximately the upper portion of the forearm over the region of the elbow. There was no skin rash evident during this examination. This employee reported that the scratches may have been due to rubbing the skin in that area with dirty shop rags (shop rags soaked with MWF).

Other Observations

A consultant reportedly conducted a noise survey for Southern Supply & Manufacturing Co., Inc. in the past, and concluded that there was not sufficient noise to warrant a hearing conservation program. The consultant's report was not available for NIOSH to review. But since the consultant's visit, machinery has been added and the ambient noise level has likely increased. The workers at the 'oil-drop' drilling station appear to be at risk of noise over-exposure, based on our observation of the drilling process itself and the use of compressed air at this workstation. Hearing protection devices are made available to all workers, though they are not required to wear them. Workers rotate through the oil-drop drilling station as a part of their job rotation.

DISCUSSION AND CONCLUSIONS

All of the personal breathing zone air samples of MWF taken from machine operators exceeded the NIOSH REL, ranging from twice the REL to nearly ten times the REL. These results indicate that current engineering controls are not sufficiently controlling MWF aerosol being produced in wet-grinding operations. While the mist collectors appear to be functioning well, the LEV inlets are placed where they cannot significantly impact the amount of MWF aerosol reaching the machine operator. The LEV inlets should be placed as close as possible to the working surface (no further than 10 inches when the mist collector is working optimally) with an unobstructed path between it and the grinding surface. As the mist collector filters become clogged, less air is drawn; therefore, as the filters become clogged the LEV inlets will need to be placed closer to the working surfaces to achieve the required capture velocity. Ideally, the grinders could be enclosed more fully, and the LEV inlet could be directly attached to the enclosure housing. Because the working surface of each grinder is not static, it may be challenging to design such enclosures while still allowing easy worker access to the grinder.

Although two employees did report occasional nasal irritation related to mist generated in the grinding process, none reported respiratory (breathing) problems related to work. One of the employees may be experiencing scratches on the skin related to rubbing used MWF over the skin – the used MWF may contain metal fines which could be causing the scratches. Our evaluation revealed that wet-grinding employees had access to clean gloves, clean towels and shop rags, and hand-washing stations, but that at least one employee was not making appropriate use of those resources to prevent skin exposure to MWF.

The noise produced by the oil-drop drilling station was uncomfortably loud in the opinion of NIOSH investigators not wearing hearing protection devices while standing 10 feet away. Workers were not required to wear hearing protection devices while working at this workstation, but may use hearing protection on a voluntary basis. A recent assessment of the noise exposures of those employees has not been done.

RECOMMENDATIONS

A complete discussion of an occupational safety and health program pertaining to MWF, including medical monitoring, fluid maintenance, engineering controls, and environmental surveillance, is contained in the NIOSH "Criteria for a Recommended Standard: Occupational Exposure to Metalworking Fluids."[5] Specific recommendations relevant to the findings of our HHE are listed below.

1. MWF aerosol exposure in the wet-grinding area should be reduced. The feasibility of enclosing and/or more effectively ventilating the grinding machines should be investigated. If engineering or other controls are not feasible, or prior to the implementation of such controls, workers whose exposures exceed the NIOSH REL should use respiratory protection. Because measured exposures were less than 10 times the REL, a particulate respirator with an assigned protection factor of 10 will provide sufficient protection. A P-series (oil-proof) filter certified under 42 CFR Part 84 should be used; the minimally protective filter would be designated P-95. Respirators should only be used within the constraints of a comprehensive respiratory protection program.[8] Users must be trained, fit-tested, and medically cleared for their assigned respirator. While Southern Supply & Manufacturing Co., Inc. should refer to the complete OSHA standard for guidance in complying with the law, further help in developing a respiratory protection program can be found in the "NIOSH Guide to Industrial Respiratory Protection."[9]

2. Education and training concerning MWF use and protection from excessive exposures should be enhanced for employees using MWF in the wet-grinding area. This is likely to be most important for new-hires or for employees recently moved into the wet-grinding area. This training should include at least the following topics:

A. Awareness and identification of potential irritants and allergens in the wet-grinding area.

B. Proper use of personal protective equipment such as gloves and special clothing. Skin should be protected from contact with irritants and allergens by the use of protective equipment such as clean gloves of an appropriate material, protective coveralls and/or apron, and sleeve protectors. The company currently provides this equipment to the employees.

C. Emphasis on personal and occupational hygiene. Irritants and allergens that have come in contact with exposed skin should be washed off with soap and water as soon as possible. Residual soap should be washed off the skin surface (soaps and skin cleansers themselves can serve as irritants). Clean shop-rags or towels, currently provided by the company, should be used to dry the skin after washing. Clothing contaminated with known irritants or allergens should be removed and laundered prior to re-use. Bins contaminated with MWF should be cleaned to reduce the potential for MWF exposure.

3. Employees should be encouraged to report all potential work-related health symptoms to their supervisor or appropriate health care personnel. Management should monitor reported health problems in a systematic manner designed to identify particular job duties, work materials (such as particular MWF), machines, or areas of the facility which may be associated with particular health effects.

4. Because new machinery has been added to the shop floor since the last noise survey was done, a new noise survey should be conducted to determine whether a formal hearing conservation program is necessary. Guidance for developing a hearing conservation program, if necessary, can be found in the NIOSH publications "Criteria for a Recommended Standard: Occupational Noise Exposure" and "Preventing Occupational Hearing Loss - A practical guide."[10,11]

5. When employees are given hearing protection devices, even for voluntary use, they should receive medical surveillance in the form of annual audiometric tests to insure that the devices are working properly and that the hearing levels of the employees are not changing.[12]

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Table 1. Air Sample Results for MWF Sampling
Southern Supply & Manufacturing Co., Inc.
HETA 2000-0262-2833
September 22, 2000

Operation	Machine ID	Sample #	Sample time (minutes)	MWF, 8-hr TWA	Extractable MWF, 8-hr TWA
inside polish	22A	17	439	3.38	3.16
inside polish	A-18-A	12	437	1.01	0.87
inside slab	A-9-A	16	443	1.05	0.89
lead operator and inside slab	A-4A	19	442	1.3	1.16
drill & tap		22	442	3.95	3.78
outside slab	4-A	21	441	0.78	0.66
assembly area	area sample	24	426	0.27	0.16
assembly area	area sample	6*	427	0.29	0.14
wet-grinding	area sample, outside slab	11	422	1.11	0.96
wet-grinding	area sample, outside slab	2*	pump failed		
NIOSH REL				**0.4 mg/m^3**	

- above concentrations are in mg/m^3.
- unless otherwise noted in the "Machine ID" column, each sample is a personal breathing zone sample.
** these two samples are total particulate, all other samples are thoracic particulate.*

For Information on Other
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www.cdc.gov/niosh

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